Opportunities for Immersive Virtual Reality in Rehabilitation: Focus on Communication Disability

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Abstract

Virtual reality (VR) technologies are emerging as novel platforms for physical and cognitive interventions, though applications in communication rehabilitation are scarce. Consultation with end-users on implementation of VR in clinical contexts is a vital first step to investigating the feasibility VR in communication rehabilitation. The aim of this study was to explore the views of professionals with expertise in health, rehabilitation, and VR technology, on the populations that might benefit from VR-based rehabilitation, and potential barriers and facilitators to their use of VR. Thematic content analysis of one interdisciplinary focus group and one in-depth interview identified two content themes relating to the use of VR in rehabilitation, and four themes related to the use of VR to maximize its clinical benefit and uptake. Consideration of these results in the development of VR programs in rehabilitation might lead to better acceptance and implementation of VR for improved health and participation outcomes.

1. Introduction

The use of virtual reality (VR) technology is advancing rapidly in many areas of healthcare and rehabilitation [1, 2]. In both physical [2-4] and cognitive [5, 6] rehabilitation, researchers have used virtual games and experiences to engage people with a variety of health conditions in novel and motivating therapies. Intervention studies have targeted physical impairments, activity limitations, and participation restrictions in people with a range of diagnoses. A systematic review of VR for the rehabilitation of limb movements after stroke found significant gains in physical activity when VR-based interventions supported or replaced traditional therapies [2]. Similarly, VR interventions targeting upper limb movement for children with cerebral palsy resulted in improved independence and participation in functional tasks, though the greatest impacts were observed in motivation to participate in therapy [4]. Implementation of VR therapy to improve the attention of people with dementia achieved positive outcomes when, compared to traditional paper-based tasks [5]. Other cognitive skills including memory, executive function, learning and problem solving have also been targeted through virtual interventions for people following a traumatic brain injury (TBI) with mixed success [6]. Participants in the aforementioned studies (with diagnoses of stroke, cerebral palsy, dementia and TBI, or others with similar conditions) often have communication disability. Despite their involvement in prior VR research trials, applications of VR to the assessment or rehabilitation of communication disability are under-researched [7].

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People with communication disability have impaired cognition, speech, language, voice, fluency and/or social interaction that may limit or restrict life activities and participation [8]. Communication disability can be caused by different health conditions, including developmental conditions present from birth or early childhood (e.g., developmental disability, autism spectrum disorder, cerebral palsy, and intellectual disability), and acquired conditions (e.g., stroke, TBI, and progressive neurological diseases). Communication disability affects approximately 88% of stroke survivors [9] with 30% of people being diagnosed with aphasia post-stroke [10]. It also affects 50% of people with TBI [11]; and most individuals with Alzheimer's disease, dementia [12], progressive neurological disease (e.g., Parkinson's or Motor Neuron Disease), or developmental disability.

1.1. Background

Interventions that utilize virtual environments are emerging to facilitate access to rehabilitation and innovative communication interventions [13-16]. While these interventions do employ virtual environments, they rely on the use of a desktop computer and point-and-click interface to engage users with the environment from a third-person perspective; that is, they require the client to take control of a character in the scene and use a headset to engage in audible spoken communication with other individuals in the virtual environment [17]. Such desktop VR technology does not permit the user to become fully immersed in the virtual environment or experience communicative interactions from a first-person perspective, as they might in the physical world. As such, skills developed in VR may not generalize to their physical communicative environments with their own communication partners. Immersive VR and its associated "feeling of presence" (p. 590) [18] may provide users with the immersive experience necessary to increase the generalization of skills gained or practiced in VR to physical, everyday interactions [18, 19]. In a practical sense, this research uses the term 'immersive VR' to describe modern head mounted devices (such as the HTC Vive® or Oculus Rift®) which include six degrees of freedom head and hand tracking within a small room-sized (3m x 3m) area. These immersive systems present a virtual reality to the user through multi-sensory feedback including visual, auditory and haptic displays to simulate real-world sensory modalities [20].

While applications of immersive VR in communication rehabilitation are theoretically sound, little is known about how individuals with communication disability, who have a range of health conditions, might access and experience VR technologies. Given that health conditions associated with communication disability have a range of cognitive, physical, psychological and social impacts, the diverse needs of such a heterogeneous population must be considered early in the design and implementation of VR technologies intended for use in communication rehabilitation [21]. Ideally, the views of a wide range of health professionals involved in rehabilitation teams should be considered, as these professionals are the potential agents of future VR interventions. They would be aware of possible issues affecting patients with lifelong and acquired conditions associated with communication disability that might impact their use of computers and VR, even though they may not be experienced in the use of immersive VR technology.

In order to address these user-centered VR development needs, this study investigated the views of an interdisciplinary panel of health professionals and a technologist regarding use of VR the in rehabilitation, with a focus on communication disability rehabilitation. By including participants with experience in healthcare or VR, we aimed to answer the following research questions:

1. Which populations with acquired or lifelong health conditions, associated with communication disability, might benefit from immersive VR technology as part of their rehabilitation?
2. What are the key barriers and facilitators to accessing VR technologies for people with developmental or acquired conditions, and associated communication disability?

The findings of this research could inform (a) the design of VR hardware and software that is accessible to people with lifelong or acquired conditions, communication disability, and a wide range of physical, sensory and/or cognitive impairments; and (b) the development of guidelines for the development and implementation of VR software for use in rehabilitation. The outcomes of this research could also help to increase the use of VR in rehabilitation, while ensuring the safety of people with communication disability so that they fully participate in VR. This could help to drive improved innovation and adoption of VR in everyday clinical settings providing services to people with stroke, TBI, cerebral palsy, progressive neurological conditions, and other conditions impacting on communication.

2. Method

Focus group methodology [22] was used to investigate factors relating to the development and implementation of immersive VR in communication rehabilitation. Using well-established focus group methods [22], the focus group discussion was moderated by the first author, lasted for two hours, and was audio recorded for later transcription and analysis. The third and fourth authors assisted the moderator in taking field notes on the discussion to add context to the transcript and guide analysis.

Key focus group questions were used to focus the discussion, and probing questions were used to explore participants' responses and foster interactions to generate new ideas. The key focus group questions were:

1. What populations might benefit from the use of this technology?
2. Do you think that clients and health professionals will engage with this technology for healthcare delivery? Why/why not?
3. What factors do you think might help or hinder clients and health professionals from accessing and using VR technology?

Prior to the discussion, all focus group participants were a 2-page factsheet containing introductory information on immersive VR, specific details about immersive VR using a head-mounted display, labelled images of the technology with descriptions explaining how the technology worked, links to videos of immersive VR being used to demonstrate the function of displays and controls, and information about how VR immerses users in computer-generated virtual environments. This was to enable participants to meaningfully imagine possibilities, despite lacking direct experience in "being immersed" in VR.

2.1. Participants

Participants in the focus group were selected from an Expert Reference Panel convened for the purposes of this research. In total, 9 health professionals and 1 VR technologist were invited and agreed to join the project's Expert Reference Panel; representing the disciplines of speech pathology, clinical psychology, genetic counselling, pharmacy, physiotherapy, occupational therapy, Indigenous health, nursing, orthoptics, and VR design and development. These individuals were invited due to their experience working with people with health conditions associated with communication disability (e.g., stroke, TBI, motor neuron disease, autism); simulation; or software design, including animation and development. They could therefore provide expert opinions and insights into the health and behavioral characteristics of patients that may help or hinder their access to VR. Although the health professionals were inexperienced in using VR, their views would likely reflect those of rehabilitation professionals who could act as agents of change to implementing VR in future clinical practice. In turn, this reflects the limited uptake of VR technology in rehabilitation settings and the emergent nature of the applications developed for rehabilitation to date.

In total, six members of the Expert Reference Panel gave their informed consent to participate in the focus group. One additional member was unable to attend the focus group but agreed to participate in a separate 45-minute individual interview with the first author, using the same key focus group questions. All seven participants completed a short demographic questionnaire regarding their discipline, years of experience, and exposure to VR and other technologies (e.g., smart phones, tablet computers, social media, online gaming and game consoles, and augmented reality). All participants were offered a small honorarium as recognition for their involvement in this research.

2.2. Data analysis

The focus group and interview transcript were analyzed using thematic content analysis [23]. Themes and codes were derived inductively from the data. The first and second authors read and re-read the transcript and listened to the audio recording to generate memos regarding initial impressions of the data. This helped to identify content themes arising in the focus group discussion and interview.

Similar ideas were grouped together into themes and subthemes and checked against the field notes taken during the focus group in order to establish an agreed qualitative coding schema. This schema was discussed with the investigators to minimize bias and ensure rigor of the qualitative analysis. Rigor was further established by: (1) an audit trail of memos created throughout qualitative coding and analysis, (2) close attention to all data and coding and progressive revision and refinement of this to ensure consistency, and (3) the use of direct quotes when reporting to provide transparency and increase the plausibility and confirmability of the results [24, 25]. Rigor was also increased through verification of the interpretation with the participants. Participants were sent a draft of this paper and were invited to provide feedback. In total, five participants provided feedback verifying that the results reflected the views expressed in the focus group and interview.

2.3. Ethics

This research was identified as nil/negligible risk and was approved by the Human Research Ethics Committee of the University of Technology Sydney, Australia (ETH19-3608).

3. Results

3.1. Participant demographics

Participants represented the disciplines of speech-language pathology, pharmacy, orthoptics, Indigenous health, genetic counselling, occupational therapy, and VR technology development (see Table 1). The highest level of qualification held by each participant included doctoral qualifications (*n* = 4), a bachelor's degree (*n* = 1), a master's postgraduate coursework degree (*n* = 1), and high-level industry experience equal to a tertiary qualification (*n* = 1).

Table 1: Health and VR experience of participants

Participant Discipline	Health Experience*	VR Experience	
		Pers.	Prof.
Genetic Counselling	20+	x	x
Indigenous Health	10+	x	x
Occupational Therapy	30	x	x
Orthoptics	25+	x	x
Pharmacy	27	✓	x
Speech Pathologist	20+	✓	x
VR Technologist	Nil 5 years in VR design	✓	✓

* Health experience reported in years
Pers. = Personal use; Prof = Professional use

Participants had an average of 20+ years of experience working in clinical, industry, and research capacities. Participants primarily gained experience through working with populations with acquired health conditions, including stroke, TBI and progressive neurological disease (*n* = 3), and the general population (*n* = 4). The panel also reported experience working with people with cancer (*n* = 2), mental health conditions (*n* = 2), and developmental disability (*n* = 1).

Three participants reported previous experience using VR technology (see Table 1). Few of the participants had experience with either augmented reality (*n* = 2) or online gaming (*n* = 3). However, participants reported using a range of other smart technologies. All used smart phones in their personal lives (*n* = 7), and some had applied this technology in a professional capacity (*n* = 4). Tablet computers (*n* = 6) and social media (*n* = 6) were also widely adopted by participants.

3.2. VR and potential user populations with health conditions

Two key themes in the data related to the populations that would likely benefit from rehabilitation interventions delivered using VR technologies. However, much of the discussion in the focus group was oriented towards the populations that might not benefit from this technology in rehabilitation. The two key emerging themes were (i) People with impairments that might initially appear to hinder use of immersive VR might benefit from its use in rehabilitation, and (ii) impairments in cognition might impact on the ability of individuals to understand and engage with VR.

3.2.1. People with impairments that might initially appear to hinder use of immersive VR might benefit from its use in rehabilitation. The participants' discussion revealed several impairments associated with conditions, such as stroke and TBI, that they considered possible factors that could limit a client's engagement with VR technology in health and rehabilitation. Attention problems and visual disturbances were particularly noted as impairments that could impact on the person's sustained engagement in the virtual word.

Visual deficits, including visual neglect, nystagmus (involuntary movements of the eye), strabismus (a squint, or turn of the eye), and diplopia (double vision), were discussed in detail as potentially limiting the use of VR, given the primary visual modality required to access the technology. Early in the discussion, these conditions were considered factors that could exclude a person from rehabilitation using VR, at least until such times as their vision had recovered. However, after the VR technologist noted that it is possible to alter the visual field within VR to accommodate visual disturbances, and that binocular vision is not necessarily a precursor to effective use of VR, the discussion shifted to the possible therapeutic value of VR for the same issues previously identified as 'limitations'. With reference to individuals with visual impairments, including low vision, the participating orthoptist noted the benefits that might exist in using VR to teach people to navigate obstacles in their environment:

"*When they're learning how to scan and do mobility training, you can do that in virtual reality in a very safe environment before they get out in the real world, and it might actually prepare them better*".

While potential rehabilitative value was identified for some conditions, there were other general circumstances identified as potentially restricting the use of VR for some people. These related more to individual factors than general health populations. For example, motion sickness, distress, and balance issues were all raised as concerns relating to the use of VR in rehabilitation. However, participants identified that these issues occur in other technological and physical interventions, and existing protocols can be used to deal with issues relating to illness, distress, and loss of balance. The speech pathologist in the group remarked:

"*Even in a research study that is without [VR] we would have to have a plan for distress and all those things, so it probably would be quite consistent with that*".

By integrating these existing protocols and interdisciplinary knowledge in the implementation of technology in rehabilitation, concerns about the detection and management of individual barriers to VR could be appropriately managed.

The participants did not identify any physical barriers to access and use of VR technology for rehabilitation, despite many of the identified populations having health conditions associated with physical impairments. Even for individuals with extensive physical disability or paralysis (e.g., spinal cord injury or severe stroke), participants expected VR to be beneficial if it was used for social activities and participation, as noted by the pharmacist:

"*A young adult in paralysis, and they've got the feeling that they are outside, or they are doing things. That actually could be great for their mental health … this is another outlet for them*".

3.2.2. Impairments in cognition might further impact on the ability of individuals to understand and engage with VR. Participants considered that, depending on the VR tasks involved, individuals with cognitive impairments (e.g., associated with stroke, TBI, or intellectual disability) might have more difficulty engaging in VR, as users presumably need some degree of cognitive ability and capacity to understand virtual therapy tasks and interact with other parties in the virtual world. These concerns were also raised in relation to individuals with either mental health diagnoses or psychosis. Participants were not sure whether individuals with cognitive impairments associated with mental health conditions, or severe intellectual disability, would be able to effectively differentiate experiences in the virtual world from those in the physical world:

"*I'm not sure if they have a good understanding of what's real and what's not real*" [pharmacist]

While participants remained open to the possibilities of using VR with people with cognitive impairments and people with mental health conditions, they also considered that VR could amplify the effects of psychosis, schizophrenia, or auditory or visual hallucinations. However, one participant's view that these psychological factors might form exclusion criteria for rehabilitation using VR, was not shared across the group.

3.3. Implementation and design considerations

The participants identified several potential barriers and facilitators to the implementation of VR interventions in rehabilitation. These factors were discussed in terms of factors that could potentially hinder the uptake of VR interventions in clinical settings, and possible solutions to these barriers. Four key themes were identified: (i) the manner of introducing VR "in the right way" so that its purpose is clear, (ii) perceptions of VR as a tool that could either isolate people or foster human connection, (iii) the cost of VR and the impact on access to rehabilitation, and (iv) the need for strong foundations of technology support for VR.

3.3.1. Introducing VR "in the right way" so that its purpose is clear. The novelty and innovation of using VR in rehabilitation programs was identified as potentially appealing to facilitate engagement with rehabilitation goals. The pharmacist, who had extensive experience in using simulation technology, explained:

"*[Virtual reality is] a different type of tool. It's innovative. It's different. It's a talking point and people may be willing to try it. It sounds a bit fun, as such, and maybe takes them away from their illness in some way*".

While this interest could increase the adoption of VR technology by rehabilitation teams, participants across the group viewed that novelty alone would not be enough to sustain interest beyond its first introduction and use. They held the view that health professionals and clients should be clearly informed as to the purpose of using VR, and educated to understand how it could be used for improved engagement in rehabilitation activities. They also considered that this would require clear training from the outset regarding how to use VR hardware and software and how to network with other users for community support and troubleshooting. Furthermore, participants expressed the opinion that VR needed to be explicitly presented as the tool used to deliver rehabilitative interventions, so use of VR was not viewed as the outcome or the endpoint, as the occupational therapist explained:

> "*I think it needs to be really clear that the ultimate goal is to be able to do it in the real world, and the goal is not to be able to do it in that virtual reality world itself. So, it's looking at that transition. It's being able to put in place how to transfer those skills. So, once they do develop [skills] in the virtual world, there needs to already be some idea as to how to make it work in the real world*".

Participants also agreed that VR interventions need to be introduced to health professionals in a way that provides them with the knowledge of how the technology is best used in rehabilitation. This knowledge would need to clearly identify the role of the technology, for example as an alternative or as an adjunct to traditional interventions. The occupational therapist further detailed that such explanations needed to outline this explicitly:

> "*Is this replacing typical therapy, or is this doing your typical therapy and then this is something you can engage in on top of that, or if it's remote, is actually going to provide therapy where there hasn't been therapy before*?"

3.3.2. Perceptions of VR as a tool that could isolate or encourage human connection. Extending from the discussion regarding the purpose of VR technologies in rehabilitation, experts expressed concern that the nature of the technology – placing an individual within a virtual environment – could be isolating for clients that engage in VR interventions. Participants agreed that interacting within the virtual world had the potential to limit or replace face-to-face human interactions. While this cautious view of VR appeared in the discussion, the group interaction led to some change of mind, as the speech pathologist's reflected:

> "*We're already there with technology. We've already got that quandary. It's not like this now is taking a new quandary that we've never seen before. It's the same thing, it's just extended*."

Participants considered that technology that could potentially isolate people already existed in social media and online gaming. They expressed that social connection obtained online through technology-based platforms should not necessarily be viewed negatively, and could be positive and enabling for some individuals, allowing them to find community, acceptance, and platforms to communicate and express themselves.

In contrast to a risk of isolation in VR was the possibility that VR might act as a medium to facilitate physical human connection in ways that other platforms cannot. For example, if VR is used within rehabilitation as a tool that teaches individuals the skills they need to function, and does so within a safe and controlled immersive environment, those skills, once mastered, could be generalized or transitioned to the physical world, as noted by the Indigenous health worker:

> "*If you then implemented [VR] in a way that is more about transitioning into the real world, it's just a better pathway than in isolation*."

In this way, VR was positioned as "*the other side of the coin*" [genetic counsellor] to popular technology platforms that encourage impersonal, text-based interactions without a physical face-to-face presence. VR within the context of an intervention was seen as a possible facilitator to the development of communication and interaction skills that could be applied in the physical world.

Age also appeared as a factor that could affect use of VR, with some participants considering that older people, both clients and health professionals, might resist VR as a rehabilitation tool due to this perception of isolation. However, other participants disagreed, noting that people of all ages are regularly exposed to and use technology in their everyday lives. Young children were also identified as a population potentially at risk in using VR, as they might be susceptible to the isolating forces of technology through increased screen time at an important stage in their development. As such, the group agreed that care should be taken in relation to the use of VR by children, as illustrated in this quote from the occupational therapist:

> "*In pediatric populations you need to be more cautious. Because they haven't had those life experiences that adults have had. They need those as well as part of their learning. Then later on as adults, if they then restrict the way they communicate with others, then that's a choice*."

VR was seen as positive step as it could be used to simulate active interactions and physical movement. This physical movement during the use of VR was identified as a useful alternative to other types of technology that encouraged passive, 'stationary' screen viewing (e.g., smart phones and tablet devices).

3.3.3. The cost of VR and the impact on access to rehabilitation. The costs involved in purchasing VR equipment and developing software programs for rehabilitation arose at multiple points in the discussion. Financial cost was identified as a factor that might have the effect of limiting access to healthcare, reinforcing the 'digital divide' rather than facilitating more widespread access through remote therapy options such as telepractice. As the Indigenous health worker said:

> "*[VR] might widen the gap. Because it's the haves and have nots and some clinics can't afford it. Government might not want to invest the money or might chose to invest it and place it in certain areas. Although it has the potential to improve health equity it might actually have the opposite effect*."

Despite these concerns, the evolution of technology arose as a counter argument to concerns of cost. Experts drew on the increasing commercial availability of the technology and the recent release of new VR headsets to point to the reducing price, as the VR technologist explained:

> "*The cost is coming down… It's getting remarkably cheap already and it's just going to get cheaper*".

While cost and access were viewed as current barriers to using VR in rehabilitation, the group agreed that, in the future, cost and expertise are less likely to form barriers as new applications are developed which provide more people with the tools and knowledge not only to use VR, but to create their own new software applications for a range of purposes.

3.3.4 The need for strong foundations of technology support for VR. For VR systems to function within the clinical contexts of health and rehabilitation, strong foundations of basic technology support were identified as an underlying issue. The lack of technical support for existing smart devices (e.g., Wi-Fi for an internet connection, video monitoring of clinic rooms, and tablet computers) led to concerns that VR would be unsupported in rehabilitation settings, as the occupational therapist explained:

> "*Where are we going to put it? Who is going to pay for it? If something goes wrong, who is going to fix it?*"

Such concerns rose to the level of clinics and hospitals failing to have reliable access to Wi-Fi internet connection, and having to ship devices hundreds of kilometers to major cities for basic technology support, including the relatively minor installation of new software applications. Additionally, group members considered that access to novel applications such as immersive VR could be limited due to firewall restrictions in major hospitals and health centers where rehabilitation services are provided.

The group agreed that without the technical and infrastructure support to implement and manage the technology on an ongoing basis, VR interventions are unlikely to be adopted and implemented in rehabilitation settings. Participants viewed that, at the individual level, access to the technology is likely to provide rehabilitation professionals with the resources needed to upskill their technology capabilities. However, the policy and system levels of health services must be addressed for VR-based rehabilitation to be feasible and have lasting effect.

4. Discussion

By consulting with health and rehabilitation professionals and a technologist, this study identified two themes relating to populations that might benefit from using VR-based rehabilitation, and barriers and facilitators to their inclusion in VR interventions; and four themes relating to implementation and design considerations in VR for health and rehabilitation. The issues and opportunities that were identified are important to consider for future applications of VR in rehabilitation, particularly in relation to populations with, or at high risk of, communication disability.

Extended discussion of populations with sensory disability (e.g., related to visual impairments) highlighted that, although such disabilities might initially be considered as limiting access to VR, the technology itself could also stimulate opportunities for VR rehabilitation. This discussion reflects the recent evolution and use of VR in physical rehabilitation, whereby people with movement disorders are immersed in VR in order to treat the movement disorders. In this study, when discussion of physical ability arose, it was met with references to existing research literature on rehabilitation of limb function, balance and gait after stroke that demonstrate physical disabilities are not actually a barrier to using VR for rehabilitation. Such studies have shown success despite access to VR requiring some level of physical capability to move within virtual environments and operate hand controllers. [2-4].

These findings likely extend to the doubts expressed by participants relating to the use of VR by people with cognitive impairments or mental health conditions. These were seen as potentially exclusionary criteria to clients engaging with VR, despite prior research that has used VR to successfully treat psychological symptoms in people with anxiety [26], and cognitive impairments in people with dementia [5] and TBI [6]. These existing studies indicate that cognitive impairments and mental health can be improved through VR, and therefore are not necessarily factors which would limit engagement in VR-based rehabilitation.

The results of this study reflect that health professionals and technologists might not view cognitive impairments in the way that they do physical or sensory impairments, in relation to the potential benefits of VR. Cognitive impairments and communication disability, unlike physical disabilities, are ‘invisible’, and this has implications for the development of VR applications for people with physical and cognitive deficits. Although focus group participants considered that intellectual disability might form a barrier to a person’s use of or benefit from VR, this arose in a context where participants lacked experience working with children or adults with developmental disability. People with developmental disability, including people with autism, Down syndrome, or multiple disabilities, are known to use VR [27]. However, the related finding that health professionals might perceive a person’s disability as a reason to use VR in rehabilitation opens the possibility that people with cognitive impairments could be included in VR rehabilitation, to work on their executive function, memory, or learning skills. Indeed, VR researchers have recognized that the use of VR by people with intellectual and developmental disability is “an open field with many opportunities to explore.” (p. 67) [27]. The results of the present study suggest that health professionals would benefit from greater awareness of VR, advancements in technology, and existing applications to the treatment of a wider range of health conditions to inform their views and adoption of VR technology in rehabilitation.

Another identified barrier was the perception that the use of VR in rehabilitation could contribute to an ever-growing debate relating to the amount of time people spend interacting with screens and computers. While technology can provide opportunities for communication (i.e., texting or teleconferencing), the absence of face-to-face social interaction appeared to be the key concern for participants in this study. Although VR in rehabilitation aims to use the technology explicitly as a therapeutic tool, this negative perception is a factor that would need to be overcome to garner the acceptance necessary for successful implementation of VR in rehabilitation. This issue would also need to be addressed in guidelines relating to the safe and ethical implementation of VR [7], and in the marketing and dissemination of any VR rehabilitation programs that are developed.

Issues relating to the cost of VR equipment are, at present, a concern for health professionals who are the agents of rehabilitative interventions that would be delivered in their clinics and health services. While the cost of VR technology is reducing as the technology becomes more mainstream and commercially distributed, professionals who are developing and testing VR interventions should continue working to establish rehabilitation programs with a view to the future. These cost concerns are likely to be significantly reduced in the future, in the same way that cost and access to tablet computers and smart devices are now met with minimal debate. However, with the underlying system-level limitations in management and technology support within health services [28], expert consultation in the development of VR rehabilitation programs may need to expand to include health service managers, information technology professionals working within health settings, and policy makers to ensure that technology is accepted and implemented effectively.

4.1. Limitations and Directions for Future Research

While the participants in this research had considerable experience in health services for people with a range of acquired health conditions, they reported minimal knowledge of, and exposure to VR technology; and little experience in working with populations with developmental disability. Their relatively low exposure to VR might have restricted their capacity to generate ideas about who would benefit from VR-based rehabilitation, and may have limited their discussion of some possibilities (e.g., the integration of multi-sensory experiences in immersive VR, including visual, auditory, olfactory and haptic feedback). Indeed, the participants’ discussion related primarily to the hypothetical use of VR. Despite this, the perspectives of health professionals are beneficial as they are the individuals who will need to adopt and implement VR-based rehabilitative interventions if these technologies are to reach populations who might benefit from using this technology. The inclusion of one VR expert in this study offered an opportunity for the health professionals to increase their awareness of VR technology through discussion, and generate new ideas about how the technology might apply to rehabilitation in the future. The inclusion of the VR expert may have also facilitated a more collaborative, creative and extended discussion owing to the insights and solutions provided as to how VR technology could overcome some of the barriers to use that were identified by the health experts, leading them to see these as opportunities. Consultation with a wider range of VR professionals might have led to the identification of additional barriers and facilitators to the access and implementation of VR for people with communication disability.

This was a small study involving only one focus group and one interview. Nonetheless, the relatively large size and duration of the focus group, and its interdisciplinary make-up, allowed for a rich and well-informed discussion, and an in-depth exploration of many issues that will inform future research. Had participants with experience in working with people with intellectual and developmental disability been included in the focus group, a greater understanding of issues affecting this group’s use of VR might have been explored. Similarly, had the study included health professionals with prior experience in VR, the findings might have reflected a nuanced expression of possibilities to benefit clients during rehabilitation, along with identifying further barriers to, and facilitators for, implementation. As such, this research should be considered as preliminary. Further investigation and stakeholder consultation are needed to verify and expand these results and facilitate the integration of findings into VR design and implementation in communication rehabilitation.

The rich content themes reported in this study offer insights into, and directions for use of, VR in rehabilitation. Researchers should engage in VR implementation studies, involving health and VR professionals, policy makers, and IT professionals to ensure that support is available at a health services management and technology level when VR is introduced as a rehabilitation tool. User-centered design and consultation will be integral to the successful delivery of any new rehabilitation technologies. The dissemination of this research to rehabilitation professionals might also help overcome perceptions that population limitations in technology use are related to age and diagnosis. As the findings of this study support the use of VR in communication rehabilitation, an immersive VR program should be designed, developed, and tested to determine if VR can successfully simulate communicative interactions with therapeutic value. Such an application will also need to be tested to ensure people with developmental or acquired health conditions associated with communication disability can safely engage with VR for rehabilitation. Further research is needed to explore the affordances of VR in relation to enhancing the participation, inclusion, or quality of life of clients using VR, social or economic benefits this provides, and drive further innovation in the design of hardware or software for implementation in rehabilitation.

5. Conclusion

When provided with information about VR and the opportunity to discuss its potential use, health professionals can recognize and generate several possibilities for VR technology in communication rehabilitation and rehabilitation more generally, with a wide variety of populations and health conditions. However, the results suggest that health professionals also hold some reservations and perhaps stereotypes (e.g., in relation to the use of VR by people of older age), and identify possible system-level barriers that will need to be overcome in order for VR to be adopted and used in rehabilitation settings. The barriers to VR that were identified, both for individuals and in the environment, do not seem insurmountable when considering the design of new software applications for communication rehabilitation in VR. For VR technology to be successfully implemented and utilized in the delivery of rehabilitation services, the barriers identified in this research will need to be addressed and supported with policy and training initiatives, so that the affordances of VR are clear to rehabilitation teams. Consultation with a variety of key user groups and those influencing use, including health professionals, service managers, IT professionals, policy makers, and the clients who could benefit from using VR in rehabilitation will be central to the success of any VR-based rehabilitation programs that are developed. By clearly addressing health professionals’ concerns in the use of VR at the point of program development, VR might be more widely accepted and implemented, leading to improved health and participation outcomes for client groups involved in its use.

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7. References

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